DESIGN AND DEVELOPMENT OF A DRAINAGE SYSTEM WITH FILTRATION AND DETENTION TANK FOR RAINWATER HARVESTING AND FLOOD MITIGATION IN PABAHAY 2000 TALAKITOK STREET BARANGAY MUZON SOUTH, SAN JOSE DEL MONTE, BULACAN

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Bachelor of Science in Civil Engineering

Major in Construction Engineering

and Management

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RECOMMENDATION

This is to certify that this research entitled " DESIGN AND DEVELOPMENT OF A DRAINAGE SYSTEM WITH FILRATION AND DETENTION TANK FOR RAINWATER HARVESTING AND FLOOD MITIGATION IN PABAHAY 2000 TALAKITOK STREET BARANGAY MUZON SOUTH, SAN JOSE DEL MONTE, BULACAN", prepared and submitted by Christian Justine Borillo, Ena Abigail C. Jacinto, Daniel S. Rimorin, have been examined and PASSED the PRE-ORAL DEFENSE.

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CERTIFICATE OF ORIGINALITY

This certificate demonstrates the fact that the work was original to the researchers and that no other individual or group has written or published it before. Additionally, it declares that until proper acknowledgement has been given to them, no honors or recognition from other universities, colleges or higher education institutions were claimed here.

On top of that, we claim that our study's intellectual content is the product of our hard work, which required using both simple terminology and efficient presentation methods in addition to the group's original ideas.

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CHAPTER 1

The Problem and its Background

This chapter presents the background, objectives, significance, scope, and limitations of the study, focusing on the design and development of drainage system with filtration and a detention tank for rainwater harvesting and flood mitigation in Pabahay 2000, Talakitok Street, Barangay Muzon South, San Jose Del Monte Bulacan. It also discusses the theoretical and conceptual frameworks that serve as the foundation of this research.

Introduction

Flooding has been one of the most enduring environmental and urban issues in Barangay Muzon. Poorly designed of drainage systems and the effects of climate change frequently worsen flooding, harming communities, damaging property and interrupting daily routines. Specifically, Pabahay 2000 along Talakitok Street in Barangay Muzon South, San Jose del Monte, Bulacan, faces ongoing flooding issues due to insufficient drainage infrastructure and lack of an effective water management system. Rainwater harvesting has surfaced as an effective method that not only enhances water availability but also minimizes

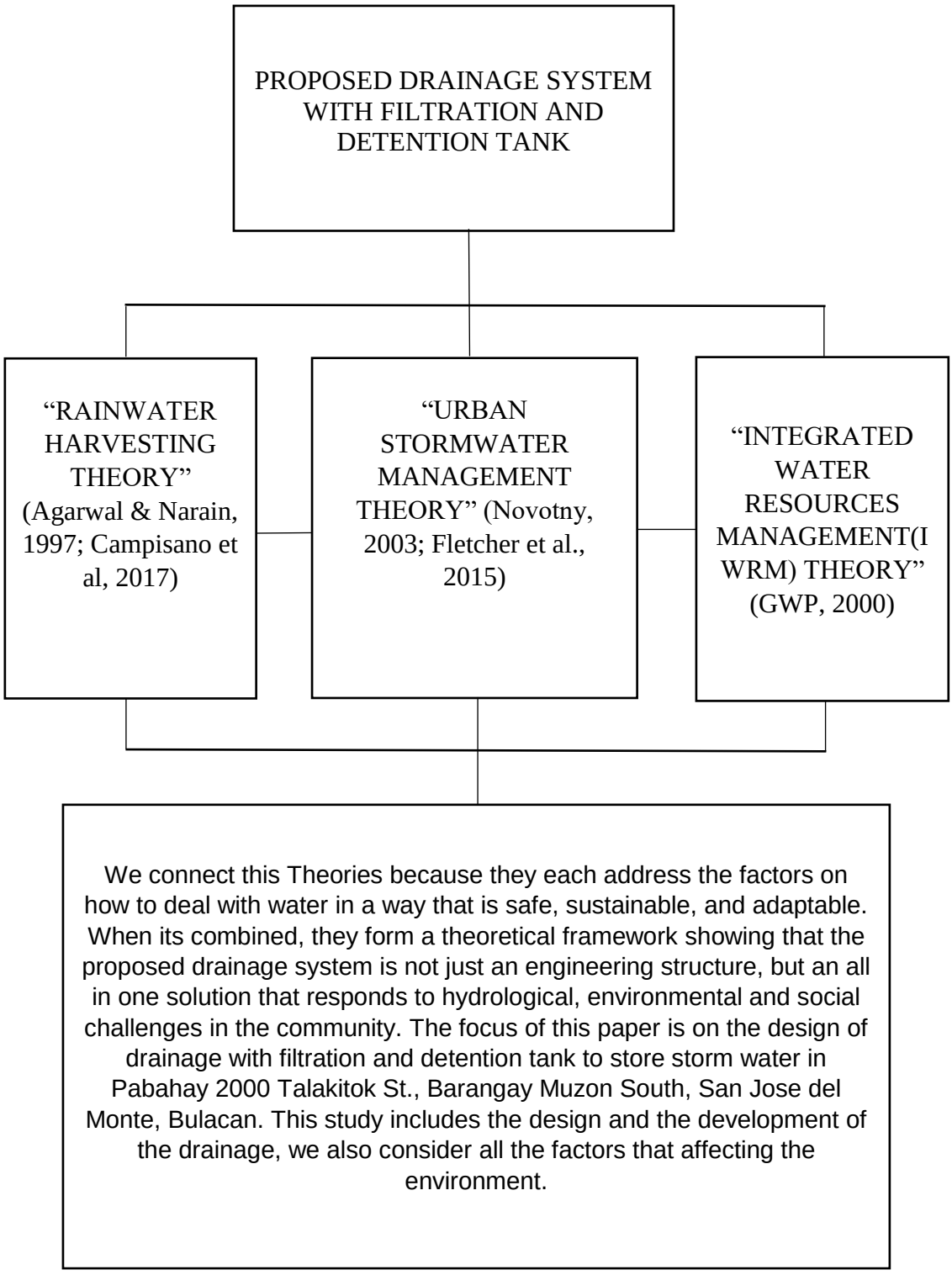
surface runoff that causes flooding. Incorporating a filtration system and detention tank into drainage design allows communities to manage flood risks and conserve water sustainably. This study focuses on designing drainage system with filtration and a detention tank to collect rainwater and reduce flooding in pabahay 2000 and offers an alternative water supply for non-drinking applications. The researchers are aiming to enhance the community adaptation, encourage sustainable water management practices, and reduce the environmental and socio-economic effects of flooding through this study.

Background of the Study

City of San Jose del Monte Bulacan is one of the rapidly-growing cities, but residents in this city have to deal with flooding and urbanization. Due to poor drainage and a lack of flood-control systems, people living in Talakitok Street in Pabahay 2000, often experiencing flooding in their areas when it rains heavily. Poor stormwater management not only worsens flooding, but also causes other problems which are caused by contact with water contaminated with sewage, animal waste, and other pollutants. Most drainage systems only focus on moving water away from homes, ignoring things like treatment, reuse, or storage. But this way of doing things is no longer acceptable because more people want to use water in

a way that is good for the environment. This research on storm water management shows how important detention tank-based systems are. The researchers came up with the idea of providing an alternative water source for non-drinking applications like cleaning, irrigation, and flushing, these systems also lessen the risk of flooding. A drainage system with a filtration and detention tank provides an innovative and practical solution for the Pabahay 2000 condition. Through rainwater harvesting, this system can improve resource efficiency while addressing the urgent problem of localized flooding. In addition to reducing the flood exposure, the researchers came up with the idea of designing the drainage that allow the rainwater to store in the detention tank. To solve the short-term flooding problems and the long-term goal of sustainable development, this research focuses on designing and building a drainage system with a filtration and detention tank on Talakitok Street, Barangay Muzon South, San Jose del Monte, Bulacan.

Theoretical Framework


PROPOSED DRAINAGE SYSTEM WITH FILTRATION AND DETENTION TANK
"RAINWATER HARVESTING THEORY" (Agarwal & Narain, 1997; Campisano et al, 2017)
"URBAN STORMWATER MANAGEMENT THEORY" (Novotny, 2003; Fletcher et al., 2015)
"INTEGRATED WATER RESOURCES MANAGEMENT(IWRM) THEORY" (GWP, 2000)
We connect this Theories because they each address the factors on how to deal with water in a way that is safe, sustainable, and adaptable. When its combined, they form a theoretical framework showing that the proposed drainage system is not just an engineering structure, but an all in one solution that responds to hydrological, environmental and social challenges in the community. The focus of this paper is on the design of drainage with filtration and detention tank to store storm water in Pabahay 2000 Talakitok St., Barangay Muzon South, San Jose del Monte, Bulacan. This study includes the design and the development of the drainage, we also consider all the factors that affecting the environment.

Conceptual Framework

Input	Process	Output
1. What is the demographic profile of the respondents in terms of: 1.1 Gender 1.2 Age 1.3 Length of Residency 2. What are the existing issues concerning the drainage system and water supply in Pabahay 2000, Barangay Muzon South, City of San Jose del Monte, Bulacan, that negatively affect the community in terms of: 2.1. Poor drainage system leading to frequent flooding during heavy rainfall 2.2. Blockages and poor wastewater flow brought on by improper installation and clogged debris 2.3. Water supply interruptions that impact sanitation and daily household activities 3. How can the proposed design of a drainage system with an integrated filtration unit and detention tank help enhance the living conditions of residents in Pabahay 2000 in terms of: 3.1. The storage capacity and retention time of collected rainwater 3.2. Reducing peak water flow and	1. Conducting surveys and interviews with residents 2. Identifying drainage problems and community needs 3. Designing a drainage system with filtration unit and detention tank 4. Selecting materials and preparing cost estimates 5. Evaluating the efficiency and sustainability of the design	1.Reduce Flooding - The new drainage design should improve water flow, prevent overflow, and lessen flooding during heavy rainfall. 2.Store Rainwater - The detention tank is expected to hold enough rainwater temporarily to reduce peak flow and delay flooding 3.Filter Collected Water - The filtration system should clean the stored water by removing dirt and suspended solids, making it suitable for non potable uses 4. Improve Water Supply -The stored and filtered rainwater can be reused for cleaning, watering plants

preventing flooding during heavy rainfall 3.3. Enhancing drainage performance, ensuring more reliable water supply, and promoting overall community well-being 4. How effective the drainage system, detention tank, and filtration system are in preventing flooding and improving the quality of harvested rainwater for non-potable uses**,** specifically in terms of: 4.1 Drainage System Efficiency -Flow efficiency -Runoff velocity -Water discharge capacity 4.2. Detention Tank Performance -Volume -Retention time -Peak flow reduction 4.3. Filtration System Effectiveness -Removal Suspended Solids -pH level -Reduction of Turbidity		and other household needs, helping the community save water 5.Provide a Sustainable Design – The system should help the community manage rainwater better, and support long term water conservation

Statement of the Problem

In this study, the researchers aim to determine the necessary data to be considered in the design of a drainage system with an integrated filtration unit and detention tank in Pabahay 2000, Talakitok Street, Barangay Muzon South, San Jose del Monte, Bulacan. Furthermore, the researchers seek to answer the following questions:

1. What is the demographic profile of the respondents in terms of the respondents in terms of

    1.1 Gender

    1.2 Age

    1.3 Length of Residency

2. What are the existing issues concerning the drainage system and water supply in Pabahay 2000, Barangay Muzon South, City of San Jose del Monte, Bulacan, that negatively affect the community in terms of:

    2.1. Poor drainage system leading to frequent flooding during heavy rainfall

    2.2. Blockages and poor wastewater flow brought on by improper installation and clogged debris

    2.3. Water supply interruptions that impact sanitation and daily household activities

3. How can the proposed design of a drainage system with a filtration unit and detention tank help enhance the living conditions of residents in Pabahay 2000 in terms of:

3.1. The storage capacity and retention time of collected rainwater

3.2. Reducing peak water flow and preventing flooding during heavy rainfall

3.3. Enhancing drainage performance, ensuring more reliable water supply, and promoting overall community well-being

4. How effective the drainage system, detention tank, and filtration system are in preventing flooding and improving the quality of harvested rainwater for non-potable uses**,** specifically in terms of:

4.1. Drainage System Efficiency

4.1.1 Flow efficiency

4.1.2 Runoff velocity

4.1.3 Water discharge capacity

4.2. Detention Tank Performance

4.2.1 Volume

4.2.2 Retention time

4.2.3 Peak flow reduction

4.3 Filtration System Effectiveness

4.3.1 Removal of Suspended Solids

4.3.2 pH level

4.3.3 Reduction of Turbidity

Objective of the Study

The purpose of this study is to provide a simple and effective solution to reduce flooding and to supply water in Pabahay 2000, Talakitok Street, Barangay Muzon South, San Jose del Monte, Bulacan through a drainage system with a filtration unit and detention tank.

1. To identify the number of residents affected by flooding in the area.
2. To describe the common problems experienced by the residents during flooding.
3. To design a drainage system with an integrated filtration unit and detention tank that can help reduce flooding and improve water management in the community.
4. To determine the most appropriate materials and construction specifications for the proposed drainage system.

General Objective

To design a drainage system with an integrated filtration unit and detention tank to help reduce flooding and promote sustainable water management in Pabahay 2000, Talakitok Street, Barangay Muzon South, San Jose del Monte, Bulacan.

Specific Objective

1. To design a drainage system that includes a filtration unit and detention tank to effectively manage storm water and lessen flooding in the community.
2. To measure how much water the detention tank can store and how it can be reused for other purposes.
3. To evaluate the possible benefits of the proposed system to the residents and the community.

Hypothesis

Ha. The design of drainage system with filtration and detention tank significantly improves rainwater harvesting efficiency and flood mitigation compared to the existing

drainage system in Pabahay 2000, Talakitok Street, Barangay Muzon South, San Jose del Monte, Bulacan.

Ho. The design of drainage system with filtration and detention tank does not significantly improve rainwater harvesting efficiency and flood mitigation in Pabahay 2000, Talakitok Street, Barangay Muzon South, San Jose del Monte, Bulacan.

Significance of the Study

This study could be important to the residents of Pabahay 2000, the people who are conducting the study and also the environment that needed to be develop.

For The Researchers - This study will be an essential reference and guide for providing consistent information regarding the design of a drainage system with filtration unit and detention tank in Pabahay 2000, Talakitok Street, Barangay Muzon South, San Jose del Monte, Bulacan.

For The Residents – This study will help the residents of Pabahay 2000, Talakitok Street, Barangay Muzon South, San Jose del Monte, Bulacan. It tells us that everyone who lives in Pabahay 2000, need an efficient and quality drainage system that stores water in the detention tank and to supply water in every house.

For The Environment - This study aims to improve the roadside drainage system for heavy rains during a storm and will mainly benefit Pabahay 2000 Talakitok Street Barangay Muzon. This includes to determine the current drainage system, evaluating sustainable design and examining the weather condition.

Scope and Limitation

This study is about designing and building a drainage system with a built-in filtration and detention tank for Pabahay 2000, Talakitok Street, Barangay Muzon South, San Jose del Monte, Bulacan. It includes storing and filtering stormwater to help with flood control and collecting rainwater in the community. The study emphasizes the efficiency testing and performance evaluation of the system in terms of reducing surface runoff and improving harvested water quality. The study is limited to the design and development of the system. It also evaluates the potential benefits of implementing such a system in the community, particularly in minimizing localized flooding and promoting sustainable water management to the residents of Pabahay 2000, for them to have an enough supply of water.

Definition of Terms

The following terms are apparently defined for the readers to understand how it will be incorporated in the study.

Catchment area- the surface or area where rainfall is gathered and directed toward a harvesting or drainage system.

Detention Tank- Storm water or rainwater runoff can be temporarily stored in a detention tank and released at a controlled rate to avoid flooding downstream.

Filtration- is the physical, chemical, or biological process of removing pollutants, debris, and suspended solids from water to improve its quality before it is stored or released.

Flood Mitigation- Strategies, structures, and practices put in place to lessen the damage, or effect of flooding on people and the environment.

Integrated- brought together or incorporated into a unified whole, functioning as a single entity.

Rainwater- is the procedure for collecting, holding, and using rainfall from sidewalks, roofs, and other catchment areas for either non-potable or potable uses.

Storm water- the rainwater and snowmelt that runs off land and impervious surfaces, such as streets and roofs, into drainage systems and natural waterways.

Surface Runoff - different water in channels with water flowing on the surface of the land.

CHAPTER 2

Review of Related Literature

This chapter presents a review of related literature and studies, following a thorough search done by local and foreign researchers. Those included in this chapter aid familiarizing with relevant and similar information to the current study.

Foreign Literature

According to Qiao Yan S et. Al (2020), Stormwater management systems play a crucial part in maintaining sanitation and livability in an urban environment by efficiently removing excess water from population centers. However, once the infrastructure for these systems has been built, these storm water management strategies have remained largely unchanged and modifications typically relied on increasing the physical capacities of the system. Spatial constraints faced in well-established cities have spurred researchers to look to alternative methods for improving existing storm water management infrastructure, resulting in a steady increase in literature in recent years focusing on real-time control (RTC) methods applied to

urban water systems. Decentralized rainwater detention tanks are usually implemented as a method for reducing rainfall runoff volumes entering centralized reservoirs and treatment plants, but these systems also provide the opportunity for harvesting and locally treating rainwater such that local demand for potable water can be reduced. The implementation of control strategies had allowed for a fourfold increase in harvested water yield and shows promise in reducing the tank capacities necessary in handling high rainfall intensities.

According to Anita R et. Al (2023), Water is crucial for human health, socio-economic prosperity, food production, and the environment. However, millions of people in developing countries lack access to clean water, a problem highlighted by the United Nations Agenda 2030's sixth Sustainable Development Goal(SDG), Clean Water and Sanitation. The growing global population and climate change are intensifying extreme events, with droughts increasing by 29% since 2000 and flooding affecting over three-quarters of the world population by 2050. Rainwater harvesting (RWH) and reuse are ancient water supply practices that are increasingly encouraged in developed countries. RWH and reuse are part of a holistic water management approach called sustainable drainage systems (SDS), which aim to manage storm water, mimic natural drainage, and encourage runoff infiltration, attenuation, and passive treatment. However, the sustainability of RWH systems is limited by their lack of specific goals and the need for extensive research in financial modeling and community

engagement. The United Nations more diverse set of SDG provides a more useful tool for illustrating the benefits of RWH.

According to Shoja R et. Al (2024), This study examines stormwater harvesting (SWH) as a solution to address urban water management challenges caused by urbanization, climate change, and population growth. Despite the potential benefits of SWH in urban areas, barriers related to planning, technological, and societal aspects have limited its widespread adoption. To address these challenges and move forward, this study presents a scoping literature review on SWH, identifying key drivers for studying SWH and exploring various factors influencing its implementation, including planning considerations, technical and non-technical aspects, and benefit of risk assessments. These factors are categorized into three phases: pre-implementation, implementation, and post-implementation. The study findings demonstrate the critical importance of considering a multidisciplinary approach and various factors in designing and implementing SWH systems, such as regulations, decision-making tools, sustainable technology, end-use, and social and economic impacts. While there is diverse motivation for studying SWH, the focus has predominantly been on technology development and testing, with limited attention given to socio-economic analysis of SWH practices.

Similarly, although there is a wealth of literature on system design optimization, there is a lack of research on regulations, post-implementation monitoring, and social analysis. However, this review highlights the substantial research in the field, which can contribute to the wider adoption of SWH practices for more sustainable urban water management in the future. The proposed comprehensive roadmap is a valuable tool for guiding future research efforts and practical implementation of SWH systems, ensuring a thorough understanding of the entire SWH system before embarking on new projects.

According to Jinjun Z et. Al (2023), Over the past 30 years, water security issue in Chinese cities had become increasingly serious, largely due to rapid urbanization, population growth and disproportionate investment in water infrastructure. Urban rainwater harvesting (URWH), a household and community-level rainwater management measure, has been widely used during this period. This study provides a critical review of the policies, methods, technology, construction, implementation and benefits related to URWH in China. We show that URWH in China has gone through three phases over the past 30 years: an initial development phase, a rapid development phase and a sponge city construction phase. URWH research has focused mainly on rainwater harvesting, storage, utilization, management and other technologies, with limited attention to policy and benefit analysis. However, the scale of URWH construction and implementation in China remains small and needs further

development. Currently, while URWH assessments cover social, ecological and environmental benefits, the economic benefits need to be further strengthened. The next step in URWH implementation should be to strengthen research and development of policy, legal and design standards. This study provides guidance for the implementation of URWH in Chinese cities and other cities alike in developing countries.

According to Srushtitha S et. Al (2024), Rainwater harvesting system plays a major role in global water conservation initiatives and provide a sustainable response to the shortage of water. The design and installation of rainwater harvesting systems are thoroughly reviewed in this work. In order to provide direction for engineers, policymakers, and practitioners involved in the planning and implementation of rainwater harvesting projects, it synthesis the body of current knowledge, case studies, and practical insights. The article covers the essential elements, design factors, tactics for implementation, and best practices to increase the efficacy and efficiency of rainwater harvesting. The ability to access dependable, clean water sources is crucial for maintaining life, promoting agricultural, many areas due to increased pressure on the world's water supply brought on by urbanization, climate change, and population development. Rainwater harvesting devices have surfaced as a potentially effective way to increase water resilience and availability in response to these issues. Maximize water collection, storage and distribution, rainwater harvesting system design is

essential. Rainwater harvesting can be optimized by designers by installing proper storage capacity, efficient conveyance systems, careful selection of catchment areas and promoting economic growth. Water scarcity problems have, however, gotten worse in these measures can minimize runoff and losses. Moreover, factors including gutter design, roof material, and slope affect the quality of collected rainwater and determine whether it is suitable for non-potable applications, irrigation, and potable use. In order to maintain the longevity and functionality of rainwater harvesting systems, proper design, construction, and maintenance are necessary for their effective implementation. Involving stakeholders cities. governmental bodies, and neighborhood associations, among others promotes ownership of the system and fosters cooperation. To prevent system failures and maximize performance over time, proper component installation, adherence to quality standards, and routine inspection and maintenance routines are crucial. Rainwater harvesting systems have many advantages and good effects in terms of the environment, society, and economy when they are designed and put into place. These systems lessen the strain on natural water sources and lessen the consequences of droughts and water shortages by minimizing reliance on centralized water supply. Furthermore, rainwater gathering strengthens communities resilience to catastrophic weather events and climate variability while also fostering self-sufficiency.

Local Literature

According to Muhamad Fathi B et. Al (2025), This study investigates how rainwater harvesting drainage systems can help mitigate flash flood risks in historic urban areas facing increasing threats from rapid development and climate change. Historic cities often have extensive impermeable surfaces, such as roads and buildings, preventing water from soaking into the ground. This leads to greater surface runoff during heavy rainfall, heightening the risk of flash floods. The research evaluates the effectiveness of existing rainwater harvesting drainage systems by combining quantitative data analysis and qualitative case studies. Field data are analyzed using the Statistical Package for the Social Sciences (SPSS) to ensure robust results. Key features of successful systems include their capacity to capture, store, and redirect excess rainwater, thus reducing surface runoff volume and speed. Early findings show that rainwater harvesting drainage systems effectively reduce flash flood risk by promoting water infiltration and conserving rainwater for reuse. These benefits align with sustainable urban development goals. Additionally, enhancing drainage infrastructure can protect public buildings, homes, and critical services from flood damage, offering economic and social advantages. The study concludes by recommending improvements in drainage system design, legal enforcement, and urban planning practices. It emphasizes the importance of context appropriate solutions and regulatory compliance to building flood-resilient historic cities. Ultimately, these insights are intended to guide urban planners, policymakers, and developers

in making informed decisions for safeguarding heritage cities from urban flooding.

According to Renier Dale D. D et. Al (2022), Water shortage and the rising cost of water services have been a problem of communities around the world for centuries. In 2019, the World Health Organization (WHO) had reported that around one out of ten, approximately eleven million people in the Philippines do not have access to improved water sources. Climate change is one of the main contributing factors to this problem. UNICEF stated that climate change disrupts weather patterns, leading to extreme weather events, unpredictable water availability, exacerbating water scarcity, and contaminating water supplies. Such impacts can drastically affect the quantity and quality of water needed to survive. Considering the occurrence of such abnormal phenomena, the aim of the study was to assess the quality of water sources in Metro Manila (NCR) and create an effective water filtration system that can be used to help reduce the contamination of water that Filipino households can utilize. The researchers gathered and analyzed data through comparative analysis, together with the support of similar studies, to help determine the optimal amount of components that will be used for the filter and establish if the filter is indeed effective in reducing contamination. The obtained results from the tests conducted for the seven water quality parameters tests between the Filtered Rainwater and Unfiltered Rainwater found that there was a reduction in the contaminants after the filtration of the rainwater using the filter

prototype.

According to Luis Carlos S. C. et Al. (2023), Flooding is a problem that requires prompt attention as it endangers the health and safety of the general public, harms homes and businesses, and interrupts transportation and other important services. The physical and mental health of people can be negatively impacted by flooding in a variety of ways. Populations living in flood-prone locations may experience repeated flooding occurrences given predictions that both the frequency and severity of flooding events will continue to rise in the future. It is one of the most catastrophic natural disasters to hit the Philippines. San Guillermo Village, the study area for this research situated in Barangay Tinajero, Bacolor, Pampanga, has been consistently inundated with severe flooding. As a result, identifying a viable solution that will provide relief to the affected residents from the disastrous consequences of such flooding is paramount such as assessing the factors that contribute to flooding in the study area. The hydraulic performance of the existing storm drainage system design was assessed using Manning's equation and Rational Method, and a suitable drainage system design was proposed, including the installation of appropriately sized pipes to improve the system's performance. In addition, this study recommended suitable strategies to mitigate the effects of flooding in the area, such as the provision of a cistern tank with a pumping

system. A more detailed calculation of the cistern tank's capacity and size was also conducted to ensure optimal water storage and usage. Overall, these recommendations aim to address the issue of flooding in the study area and to provide effective and sustainable solutions for the benefit of the affected residents.

According to Aure Flo O. et Al. (2023), Rainwater is an abundant resource in the Philippines and when properly collected and managed, can help address flood problems. Rainwater harvesting has been practiced for years and has been viewed as one of the better options for flood mitigation in urban areas compared to other storm water management practices. It does not require large land area and cost per area is high in these locations. However, there is a challenge in selecting the suitable tank size. This paper investigates if the increase in storm water runoff brought about by the changes in land use in urbanized catchments can be represented by a single coefficient similar to what is being presented in the Philippine Green Building Code and in other local ordinances in the country. Simulations through HEC-HMS of three urban catchments in Metro Cebu showed that the increase in volume is highly varying such that the coefficient produced for each catchment was so distinct that no single average coefficient can be drawn. Thus, analysis should be catchment-based to determine the suitable tank size in rainwater harvesting systems as an option for flood mitigation.

According to Anastacio G. P. Jr et Al. (2024), Urbanized areas in Northeastern Mindanao have a problem of addressing flooding occurrences. This study primarily aimed to provide insights into how the rainwater catchment system of uptown communities and their cooperation could increase flood resiliency of downtown communities in the Surigao del Sur, Caraga Region, Philippines. This research employed quantitative analysis of the eleven (11) year (2010-2020) data from the Philippine Atmospheric, Geophysical, and Astronomical Services Administration - Hinatuan, Surigao del Sur station. The recommendable optimum rainwater storage capacities for a given number of household occupants, roof areas at run-off efficiency of 90%, and three (3) day rainfall characteristics at 36.9% averaged probability of exceedance where initially determined. Through scenario analysis, uptown communities emptying their rainwater storages before heavy downpour occurs could provide sufficient flood volume reduction and buffer time for downtown communities to prepare. The output of this research is vital in the environmental planning, management, and policies of cities and regions.

Foreign Study

According to Shiping W et. Al (2024), The volume capture ratio of annual rainfall of low-impact development measures is significantly influenced by its operating characteristics, particularly for residential storm water detention tanks. The multi-objective operation strategy

of storm water detention tanks, encompassing toilet flushing, green space irrigation, combined toilet flushing and green space irrigation, and peak flow reduction rate, were compared using a case study in Beijing based on the storm water management model. The findings indicate that the volume capture ratio of annual rainfall for toilet flushing, green space irrigation and rainwater harvesting targets was 89.05, 77.16, and 91.21%, respectively. The operating scheme and return periods have a significant impact on the peak flow reduction rate's effectiveness. When the return period was lower than 10 years, the storm water detention tank does not reach its maximum storage capacity, and the peak flor reduction rate was increased with increasing the return period: the peak flow reduction rate was 71.47% when the design return period was 10 years. It will also produce the phenomena of water inrush and the overflow volume will grow rapidly when the storm water detention tank reaches its maximum storage capacity. Hence, the operation of storm water detention tanks may be integrated with real-time control to optimize the volume capture ratio of annual rainfall for rainwater reuse and flood migration, thereby enhancing the volume utilization efficiency of storm water detention tank.

According to Abbas A et. Al (2025), In response to increasing water scarcity and the pressing need for cost-effective and sustainable wastewater solutions, particularly in small communities, this study investigates the performance and feasibility of a simple, low-cost

decentralized hybrid system combining a detention tank with a filter. The system was designed to treat domestic and municipal wastewater with the goal of promoting safe reuse in water-stressed regions. A detention tank with filter unit was constructed and tested using synthetic wastewater, raw sludge, and real municipal wastewater. Key performance indicators included chemical oxygen demand (COD), biochemical oxygen demand (), total nitrogen (TN), total phosphorus (TP), ammonia nitrogen (), phosphate (), total suspended solids (TSS), and hydraulic retention time (HRT). Under optimized conditions with synthetic wastewater, the system achieved removal efficiencies of 94% for COD, 83% for, and 63% for at a 24-hour HRT. When tested with actual municipal wastewater over two weeks, the system showed removal efficiencies of 73.8% for COD, 77% for BOD_5, 78% for TN, 58% for TP, and 95% for TSS. These results confirm that integrating a detention tank with a filter provides a reliable and efficient approach to decentralized wastewater treatment. The treated effluent met environmental standards, supporting its potential reuse in irrigation. This study highlights the practicality and scalability of simple treatment technologies as viable solutions for rural and underserved communities facing increasing water stress.

According to Hsin-Yuan T et. Al (2025), Taiwan experiences abundant rainfall, but faces significant water shortages, making rainwater harvesting (RWH) a potential alternative

water source. Additionally, extreme rainfall events strain urban flood control systems, highlighting the need for integrated storm water management. To address these challenges, Taiwan mandates storm water detention (SWD) in new buildings. However, the current RWH and SWD systems are designed independently, with no combined design guidelines available. This study proposes three combined RWH and SWD systems, series, parallel, and enhanced parallel with a valve using a passive release mechanism. System performance was evaluated through short-term and long-term simulations. Short-term simulations were conducted to ensure the system's compliance with the domestic flood control design standards. These simulations assessed the peak flow mitigation and lag times for 5-, 10-, and 25-year design storms under four scenarios. Long-term simulations used historical rainfall data to analyze the differences in the combined systems and operational plans for continuous rainfall events. Three performance indicators volumetric reliability, the storm water retention ratio, and the storm water detention ratio where employed to assess water supply and the storm water detention performance. The short-term simulation results revealed that the system performance was sensitive to the initial conditions. The series and parallel systems performed well, while the enhanced parallel system outperformed the others under specific initial conditions and valve operations. In contrast, long-term simulations revealed that the series and parallel systems achieved higher storm water retention and a more stable performance

than the enhanced parallel system. Among the three systems, the parallel system offers reduced installation space, lower costs, and easier maintenance, making it the recommended option for Taiwan. This study provides valuable guidance for designing combined RWH and SWD systems.

According to Pedro Carlos Lemos da C et. Al (2021), Rainwater harvest is a desirable alternative clean technology where water is scarce, but the economic viability of its implementation is reduced by the need to install pumps and pipes. The type of filter bed and the frequency of filter changes can increase costs, compromise the quality of the water obtained by this treatment and increase the environmental impacts. This study focuses on a system for collecting and treating rainwater that is compact, innovative, dispenses with the use of pumps, and can be adapted for use in homes and industries, contributing to clean production. An acrylic blanket (Acrylon) was used as a filtering medium because it is a low-cost alternative and is easy to obtain and handle. The experiment was carried out in a company located in the industrial city of Itaboraí (Rio de Janeiro). Water characterization was monitored before and after contact with the roof, and after passing through the treatment equipment (11 rain events). Samples were collected in triplicate; the first sample was collected within 10 min of the onset of rain (first flush), the second after 15–30 min of rain, and the third after 30 min of rain. The second and third samples were used to generate a

“continuous” sample. The evaluated parameters were turbidity, apparent color, hydrogenionic potential, temperature, free residual chlorine, and the presence of coliforms (total and tolerant). The apparent color removal efficiency was 81.70% for first flush and 49.54% for continuous samples, and the turbidity removal efficiency was 74.28% and 52.19%, respectively. These removal efficiency results are similar to those achieved by traditional rainwater treatment systems that do not discard the first flush. It was found that the treatment met the requirements of the Brazilian standard for the use of rainwater based on turbidity (less restrictive standard), residual chlorine, and absence of coliforms, but did not meet the requirements for hydrogen potential and color removal.

According to Arthur Borges B et. al (2025), This study evaluated the allocation of residential detention tanks in the Alto da Boa Vista Condominium, Federal District, Brazil, using hydrological and hydraulic modeling using the PCSWMM software (version 7.6.3610). The objective was to investigate the impact of urbanization on local hydrology, considering the occurrence of erosive processes in the area. Critical points in the infrastructure and regions susceptible to flooding were identified. The methodology involved implementing residential detention tanks in different allocation scenarios, including the use of isochrones. Isochrones, which represent lines of equal concentration time in the drainage network, were employed to segment the basin into three main regions: upstream (ISO 1+2), central (ISO

3+4), and downstream (ISO 5+6). The isochrone-based scenarios enabled the assessment of the impact of concentrating residential detention tanks in these specific zones. Additionally, two other scenarios were analyzed: one with the residential detention tanks uniformly distributed throughout the basin and another without the presence of these devices. Finally, a scenario with a random distribution of residential detention tanks was tested, encompassing a total of 54 distinct configurations, to investigate the influence of different spatial arrangements on the basin's hydraulic performance. The results indicated that the number of residential detention tanks installed is the main determinant for peak flow attenuation at the basin's outlet. It was observed that, regardless of the distribution of the devices, whether in concentrated scenarios (upstream, central, and downstream, as defined by the isochrones) or in randomly distributed configurations, the results were similar. In all cases, installing residential detention tanks in more than 30% of the basin area resulted in an approximately 5% reduction in peak flow at the outlet. It is concluded that implementing residential detention tanks are an effective and feasible solution for sustainable storm water management, significantly contributing to surface runoff control and peak flow mitigation in urbanized areas.

Local Study

According to Ian Christian L. D et. Al (2025), This study presents the design of a rainwater harvesting (RWH) facility with a filtration system to supply potable water to the Ayala San Agustin Farmers Association (ASAFA) community in Magalang, Pampanga. This elevated community continues to face water shortage due to a malfunctioning solar submersible water pump and limited access to the public water supply. With these in consideration, the study aims to provide an alternative water source to the community using the collection, treatment, storage, and distribution of rainwater, aligning with Sustainable Development Goal 6 for water security. Applied research guided the design process, involving site selection using Quantum Geographic Information System (QGIS), rainfall data analysis from the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA), and structural modeling with STAAD Pro and AutoCAD. The facility has a roof catchment, conveyance system, water tanks, and a filtration system consisting of gravel, sand, filter wool, and activated coconut carbon. Moreover, this gravity-fed system distributes the water to the community stations. A prototype confirms that the design works in collecting, storing, and distributing water. However, water testing indicated initial potability problems. Hence, further testing at least three times and consideration of alternative filtration procedures are recommended to guarantee water potability.

According to Mariella Nicole D. T et. Al (2025), Prolonged flooding has been a persistent issue in Barangay Sta. Monica, San Simon, Pampanga particularly during the rainy season, leading to disruptions in daily life and public health concerns. This study designed a drainage system for flood mitigation to address these challenges. The HEC-HMS was used to create a hydro-logical model of the study area. In total, three sub-basins were delineated, with Sub basin 1 representing the majority of Barangay Sta. Monica. Simulations for 2-, 5-, 10-, 15-, 20-, 25-, 50-, and 100-year return period showed a steady rise in peak discharges, with the highest flow recorded at 62.4 m^3/s during the 100-year return period. The Rational Method and Manning's Equation were used to generate an initial design, which was then evaluated and optimized using SWMM simulations. The final design features a rectangular reinforced concrete drainage channel measuring 1.3 meters deep and 1 meter wide, with a total length of 5.87 km. Additionally, the design considered the variation of road width. The system's outfall recorded a flow frequency of 98.03% in the SWMM simulation, indicating its consistent ability to route storm water effectively. The total construction cost, including the material, labor, and equipment expenses was estimated at ₱93,071,605.3.

According to Jao Hallen B et. Al (2022), This study utilized a geospatial approach to identify suitable sites for rainwater retention areas in Mandaue City, a highly urbanized city in Cebu, Philippines. Based on the integrated use of remote sensing and Geographic Information

System (GIS), ideal sites for rainwater retention were produced to divert surface water runoff from flooding the streets and obstructing traffic. Ideally, the chosen sites should have low infiltration capacity and be within open spaces. For the hydrological planning of the study, we considered the amount of surface runoff, elevation, soil characteristics, land use, and present drainage status of the study area. The Digital Elevation Model (DEM) derived from LiDAR technology is used to obtain the slope raster and generate small streams. Land cover and curve number (CN) of the area were used to compute the surface runoff. The soil textures were converted based on their infiltration rate and runoff potential. Finally, the weighted overlay tool in GIS created a layer identifying potential areas for rainwater retention sites. The findings indicate that 54.8% of the research area was ideal for water harvesting, with open land areas making up 2.3% of the best locations. In addition, a major portion of the appropriate locations lies in clay loam soils and within 0-25 meters in elevation. These results will hugely benefit policymakers and urban planners in helping create solutions to the city's flooding problem and the looming water crisis.

According to Mariusz S et. Al (2020), To determine the effectiveness of the retention partitions, the detailed model tests were carried out. The research results allowed indicating what values of the hydraulic parameter of the innovative drainage system should be adopted in order to effectively use the retention capacity of drainage collectors. The adoption of short

distances between the LKR damming partitions and a high level of permissible rainfall of storm water High Permissible Rainfall (Hper) turned out to be the most effective solution. In the most favorable conditions, the peak flow was reduced by up to 60% (717.46 dm^3/s) compared to the values established in the traditional drainage system (1807.62 dm^3/s). The benefits obtained resulted from the increased retention efficiency of the drainage system after equipping it with the damming partitions. It was found that the innovative system always achieved the maximum retention capacity with longer rainfall compared to the traditional system. In the real catchment area, an increase in the use of the retention capacity of the drainage system, from an initial value of 65% for a traditional system to almost 88% for an innovative system, was also found. Very large variability of the volume of accumulated storm water in the conduits of the traditional and innovative drainage system was observed during rainfall, which generated the peak rainfall discharge in the innovative system. With rainfall of TRK duration, the innovative system accumulated up to 746.50 m^3 more storm water compared to a traditional system, which was 49.2% of the total retention capacity of the drainage system, with a value of 1515.76 m^3. The approach to reduce the growing flood risk in cities provided the right approach to long-term urban drainage system planning, especially since traditional drainage systems are still the leading way to transport storm water in cities. In addition, the innovative sewage system gives the possibility of favorable cooperation with any objects (LID) and detention tanks with any hydraulic model. The

implementation of an innovative system allows achieving significant financial savings and reducing the need to reserve areas designated for infrastructure investments.

According to Fillmore D. M et. Al (2024), The looming water crisis and environmental problems aggravated by climate change, such as flooding, the implementation of RWH systems for different applications is deemed an effective solution, especially for areas with abundant rainfall, such as Davao City. This study utilized QGIS to map suitable site for open area rainwater harvesting (RWH) systems in Davao City, Philippines. This study aimed to identify potential location sites for RWH systems in Davao City by producing suitability maps using weighted overlay analysis. The Weighted Overlay Analysis was implemented to produce a suitability map based on the assigned weights of datasets to influence the overall RWH suitability. The datasets employed include slope, rainfall, land use, soil type, and lineament density. Findings show that the very highly suitable areas for RWH systems are located mostly in the districts of Marilog, Baguio, Calinan, Paquibato and some parts of Tugbok. In addition to the same districts, Calinan, and Tugbok have highly suitable areas for the RWH system. Unsuitable areas, or areas that were not recommended to implement RWH systems were concentrated in the district of Agdao, Buhangin, Bunawan, and Poblacion, where urban areas are located. The resulting suitability map can benefit the local authorities and planners in implementing RWH systems for the development of city’s agriculture in

water resource conservation, and flood management, supporting sustainable development and climate resilience in Davao City.

Synthesis of Review of Related Literature and Studies

Flooding remains a major issue in many low-lying areas in the Philippines, including Pabahay 2000 in Muzon South, Bulacan, where poor drainage and climate change worsen the problem. Similar situations in Pampanga have been addressed through improved drainage designs, such as the hydrological system developed by Mariella Nicole D. T. et al. (2025). Rainwater harvesting (RWH) and storm water detention systems have been proven effective in reducing surface runoff and providing extra water supply. For example, Ian Christian L. D. et al. (2025) built an RWH system with filtration for upland communities, while Luis Carlos S. C. et al. (2023) recommended cistern tanks and pumping systems to help manage urban flooding. International studies support these solutions. In Brazil, Arthur Borges B. et al. (2025) found that installing detention tanks in over 30% of an area reduced peak flow significantly. In China and Taiwan, systems that combine RWH and detention tank. Like those studied by Shiping W. et al. (2024) and Hsin-Yuan T. et al. (2025) not only reduced flooding but also enabled water reuse. Tools like GIS and remote sensing (Jao Hallen B. et al., 2022; Fillmore D. M. et al., 2024) help identify ideal locations for these systems. Qiao Yan S. et al.

(2020) further highlighted that real-time control (RTC) can improve storm water system efficiency, even in space-limited urban areas.

CHAPTER 3

Research Methodology

This chapter focuses on the study and how we begin by outlining the steps, number of respondents, surveys, tools, and research design used in the study. By following these processes, we will be able to respond to the questions of whether this study can collect data using the methods described in this chapter.

Research Design

This chapter focuses on the study and how we start by describing the procedures, research design, instruments, surveys and number of respondents in the study. The issues of whether this study can gather data using the techniques outlined in this chapter can be answered by following to these procedures. This chapter's conclusion focuses on the data collection procedure at Pabahay 2000 Talakitok Street, Barangay Muzon South, San Jose del Monte, Bulacan.

Sample and Population

This research project conduct in Pabahay 2000, Talakitok St., Muzon South, San Jose del Monte, Bulacan, target population estimate 80 respondents from 50 selected households. These individuals were chosen to represent the community affected by flooding and poor drainage. The design and development of a drainage system with filtration and a detention tank aimed at enhancing rainwater harvesting and flood mitigation benefited greatly from their observations and insights from the area. Purposive sampling is a sampling technique used to ensure broad participation in local events by selecting respondents based on their cooperation. This method allows for the collection of diverse perspectives while maintaining a manageable sample size for analysis.

Sample Size:

-Total Population: 50 households

-Sample Size: 80 respondents

Research instrument

In this study, we'll be using a simple questionnaire and face-to-face interviews to gather information from the residents of Pabahay 2000, Talakitok St., Muzon South, San Jose del

Monte, Bulacan. The questionnaire includes around 8 to 10 questions that ask about things like the residents' background, their experiences with flooding, the condition of their current drainage system, what they know about rainwater harvesting, and their thoughts on our proposed drainage system with a filtration and detention tank.

We plan to visit the community and conduct the surveys in person over a span of 3 to 5 days. The interviews will be scheduled on different days to give enough time for each person to share their insights. This method will help us better understand the real issues faced by the community and gather helpful feedback for designing a more effective and sustainable drainage system.

Data Gathering Procedure

The researcher collected the desired data using a questionnaire. The questionnaire is distributed to respondents and approved by panelists and some professors who have knowledge in research. Data for the project were collected through surveys and interviews with local residents to assess existing drainage conditions and flooding issues. The Findings were summed and tabulated based on how frequently respondents checked the

items. Following tabulation, the findings were analyzed using a variety of statistical instrument.

Statistical Treatment

Due to the quantitative nature of this study, emphasis was placed on numbers, important figures and data was displayed and analyzed quantitatively applying statistical methods. Resident's responses to the researchers surveys and their demographic profile were determined using frequency count and percentage. The statistical method below was used by the researchers because they considered it was acceptable.

$$P = Fx100/N$$

Where:

P = Percentage

F = Frequency

N = Total Number of Respondents

Flow rate formula **Q= ciA** Where: **Q**= Flow rate (cu.m/s) **c**= Runoff Ratio **i**= Average rainfall intensity (mm/hr) **A**= Drainage area (sq.m)	**Flow regulating hole/opening in detention tank** **Q= CA√2gh** Where: **Q** = flow rate (cu.m/s) **C**= ratio of flow rate (sq.m) **g** = acceleration from gravity (9.81 m/s^2) **h** = head acting on the centerline (m)	**Storage rate of Detention Tank area** **I-Q=S** Where: **I**- Inflow **Q**- Outflow **S**- Storage